TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (CA/FACE) Program

SUBJECT: Two Engineers Die after an Explosion Occurred at an Explosive Test Facility

SUMMARY

California FACE Report #94CA015
June 15, 1995

A 51-year-old white, non-Hispanic, male engineer (victim #1) and a 53-year-old white, non-Hispanic, male engineer (victim #2) died when an explosion occurred while they were at work testing chemical compounds. Both of these victims were pyrotechnic experts. A third worker was also hospitalized with second and third degree burns. The three workers were testing chemical compounds in order to enhance the ignition of solid and liquid propellants in rocket engines. At the time of the incident, the ambient temperature was 81 degrees F. and the relative humidity was 17%. The ignition procedure involved putting sawdust on a flat metal sheet, followed by a layer of glycidylazide polymer, and finally a layer of nitrocellulose. The sheet was surrounded by metal shields. An electric match and a small pouch of black powder were used to ignite the substance once everyone was safely out of the area. Two tests had been conducted that morning and a third test was being set up when the explosion occurred. According to co-workers, the chemicals were in place and one of the victims was about to, or was, adding more nitrocellulose to the mixture when a loud explosion occurred. They ran to the site of the explosion and found both victims with obviously fatal injuries. The third worker was found lying approximately 10 feet from the blast site. The CA/FACE investigator concluded that in order to prevent similar future occurrences, employers should:

- establish, implement and maintain an effective, written Injury and Illness Prevention Program (IIPP), specifically referencing safety training procedures for all new tasks and and how inspections should be conducted to identify and evaluate hazards with regard to any new tasks.
- prohibit employees from processing or blending static sensitive explosives in less than 20 percent relative humidity.
- not allow the processing, blending and/or mixing of explosive materials in an area immediately adjacent to a test stand which had been used during a previous test.
- ensure that employees working with highly ignitable materials and their equipment are properly grounded.

INTRODUCTION

On July 26, 1994, a 51-year-old white male principal engineer specialist (victim #1) and a 53-year-old white male senior engineer specialist (victim #2) died during an explosion which occurred while they were at work testing chemical compounds. The CA/FACE investigator learned of this incident through a metropolitan newspaper article. No site investigation was conducted in this incident due to logistical constraints. Copies of the California Occupational Safety and Health Administration's (Cal/OSHA) Report, the Police Report, and the Medical Examiner-Coroner's Report were all obtained by the CA/FACE investigator.

The employer in this incident conducted rocket engine testing for a federal government program on a 2,700 acre facility. The company employed 742 employees. The victims had been working at an outdoor test stand near one of the facility labs when the explosion occurred. According to a spokesman at the facility, the test explosion was normally triggered electronically by technicians standing at a safe distance. He stated that he was not sure in this incident how far the victims were from the source of the blast.

INVESTIGATION

On the day of the incident, the two victims and three co-workers were in the process of testing chemical compounds in order to enhance the ignition of solid and liquid propellants in rocket engines. The material was tested to determine its characteristics so it could be properly packaged, labeled and transported. Two tests had already been completed successfully and the victims were in the process of setting up for a third test. The setup procedure involved putting sawdust on a flat metal sheet (26" x 18"), followed by a layer of glycidylazide polymer (GAP), and finally a layer of nitrocellulose (NC). The sheet was surrounded by metal shields. Both of the materials used in this experiment are Class B explosives. An electric match and a small pouch of black powder was then used to ignite the substance once everyone was safely out of the area.

At approximately 9:07 a.m., after the smoke had cleared from the second test, co-workers returned to the test area and smothered the small amount of residual ash with dirt. The cooled pan from the first test was dumped out and set up again. The contents of the pan were sawdust (3/4"), GAP (5 lbs.) and NC (approximately 1 1/2"). One of the victims had gone back to a cabinet to retrieve more NC and was returning or had returned to the test site when the explosion occurred. It was unknown whether this victim was in the process of adding more NC to the contents of the pan or whether he was still en route to the pan when the explosion occurred. Co-workers immediately summoned emergency help. An injured worker was found approximately 10 feet from the explosion site. This individual had second and third degree burns to over 20% of his body. He was taken by a co-worker to the control center because that co-worker felt it was unsafe to remain in the incident area. When emergency personnel arrived at the site co-workers directed them to one of the victims. The two individuals (victims) working closest to the test site were killed instantly by the explosion. The injured co-worker was taken by helicopter to a burn center where he was initially listed as being in critical condition.

According to the victim's co-workers, a static charge could have caused the explosion. NC has a flash point of 63 degrees F. and the ambient temperature was 81 degrees F. The humidity at the site was 17%, and at humidities less than 20%, a spark could have been created simply by pouring these chemicals together. This spark could then have ignited the NC. If the container used had not been completely cooled prior to its re-use, a hot spot within the container could also have increased the risk of ignition. Finally, the pan was not grounded, so static charges would have been able to accumulate, further increasing the risk of a spark.

CAUSE OF DEATH

The Medical Examiner-Coroner's Report stated the cause of death for victim #1 to be blunt injuries due to detonation, and for victim #2, disintegration due to detonation.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should establish, implement and maintain an effective, written Injury and Illness Prevention Program (IIPP), specifically referencing safety training procedures for all new tasks and how inspections should be conducted to identify and evaluate hazards with regard to any new tasks.

Discussion: Although the victims and injured co-worker in this incident had extensive experience with explosives, the particular task they were performing at the time of the incident was new. None of the workers had been given specific training for such a task. Under Title 8 of the California Code of Regulations (CCRs) section 3203 (a), effective July 1, 1991, every employer shall establish, implement and maintain an effective Injury and Illness Prevention Program (IIPP). The program shall be in writing and, shall, at a minimum: (1) identify the person or persons with authority and responsibility for implementing the Program. (2) include a system for ensuring that employees comply with safe and healthy work practices. Substantial compliance with this provision includes recognition of employees who follow safe and healthful work practices, training and retraining programs, disciplinary actions, or any other such means that ensures employee compliance with safe and healthful work practices.

Recommendation #2: Employers should prohibit employees from processing or blending static sensitive explosives in less than 20 percent relative humidity.

Discussion: In this incident the victims and their co-workers were processing and blending static sensitive explosives in 17 percent relative humidity. Under Title 8 of the CCRs section 5329 (b), the working area where the screening, grinding, blending, and other processing of static-sensitive explosives or pyrotechnic materials, is done shall be maintained above 20 percent relative humidity. If the relative humidity drops below 20 percent, the above operations shall be stopped and secured until the relative humidity can be raised above 20 percent. It is desirable to keep the relative humidity above 20 to 30 percent, except where metal powders are involved, in which case the relative humidity should be between 50 and 60 percent.

Recommendation #3: Employers should not allow employees to prepare a test stand immediately adjacent to and within 48 hours of a prior test fires. Scrap material should also be removed from test areas before any new tests are conducted.
Discussion: In this incident, had the pan been insufficiently cooled, a hot spot would have increased the risk of ignition. Employees had prepared a test stand immediately adjacent to and within minutes of a previous fire and scrap material had not been removed from the burn area. Under Title 8 of the CCRs section 5331 (b), provisions shall be made so scrap explosive material will not be placed in any burn location until at least 48 hours has passed since the last fires have gone out.

Recommendation #4: Employers should ensure that employees who work with highly ignitable materials and their equipment are properly grounded.
Discussion: In this instance, static charges could have accumulated on the employees or during the process of mixing the chemicals. If the employees and the pan had been grounded, the static charge would have been dissipated with less chance of a subsequent spark.

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June 15, 1995

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the Public Health Institute and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations of work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal by studying the work environment, the

worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact. NIOSH-funded, state-based FACE programs include: Alaska, California, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, Oregon, Washington, West Virginia, and Wisconsin.

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Additional information regarding the CA/FACE program is available from:

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